

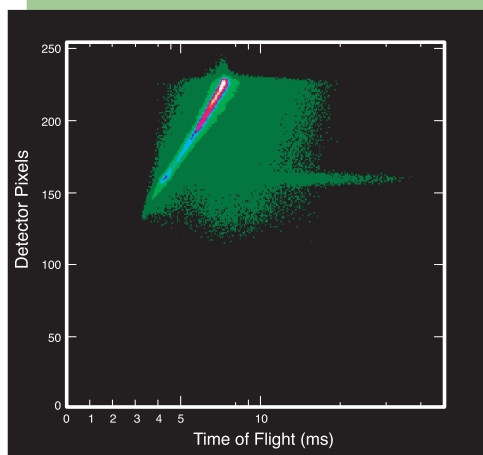
Surface Profile Analysis Reflectometer (SPEAR)

The Surface Profile Analysis Reflectometer (SPEAR) is used for determining chemical density profiles at solid or liquid interfaces. This instrument is used with an unpolarized neutron beam to study solid/solid, solid/liquid, solid/gas, and liquid/gas interfaces. SPEAR's moderated neutrons are coarsely collimated into a beam with an average angle of 0.9° to the horizontal that converges at the sample position, which is 8.73 m from the moderator. The neutrons can be further collimated to the desired divergence by finely slitting the beam. The largest vertical divergence is $\pm 0.25^\circ$. In the horizontal direction, the beam converges at 12.38 m, the detector position, with a maximum angular divergence of 0.45° .

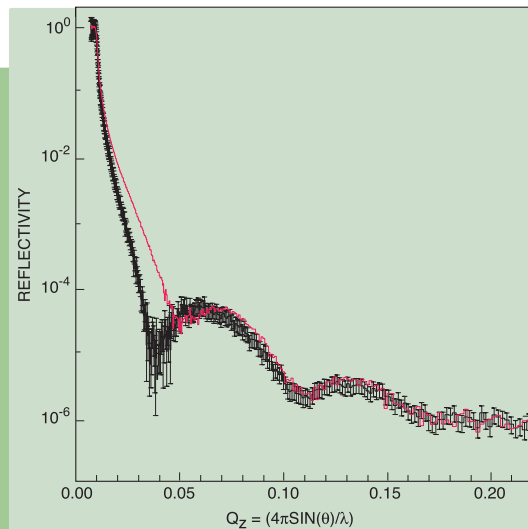
A t-zero chopper, which interrupts the beam during the initial flash of high-energy neutrons and gamma rays, significantly reduces the background that may limit reflectivity measurements. A frame-overlap chopper, which defines the wavelength band to be used, suppresses frame-overlap background problems.

The sample stage allows solid samples to be accurately tilted in order to change the angle of incidence of the beam relative to the reflecting surface and permits sample-height scans for centering the samples in the beam. A vibration isolation system (Newport Corporation) supports the sample and actively dampens vibrations transmitted through the floor or air. SPEAR uses a single linear position-sensitive detector with 2-mm, resolution for simultaneous studies of both specular and off-specular scattering.

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Color intensity plot of specular and off-specular neutron reflection data from the near surface scattering of a surfactant at a solid/liquid interface.



Reflectivity vs Q_z plot for an annealed polymer thin film.

SPEAR Specifications	
Moderator-to-detector distance	12.38 m
Wavelength frames at 20 Hz	$1 < \lambda < 16 \text{ \AA}$ and $16 < \lambda < 32 \text{ \AA}$
Q range (horizontal sample)	$0.006 < Q < 0.20 \text{ \AA}^{-1}$
Beam cross section at sample position (maximum sample acceptance)	8 mm high x 30 mm wide
Moderator	Partially coupled liquid hydrogen at 20 K
Neutron flux at sample position at 100 μA	$2 < \lambda < 6 \text{ \AA}$: $7.0 \times 10^6 \text{ n/cm}^2/\text{s}$ $6 < \lambda < 16 \text{ \AA}$: $1.5 \times 10^6 \text{ n/cm}^2/\text{s}$
Detectors	Linear ^3He position-sensitive detector
Minimum reflectivity	$< 10^{-7}$
Sample environment	Solid/liquid interface cells; UHV evaporator; UHV oven; Langmuir trough; controllable humidity oven; and solid/liquid interface Poiseuille shear cell
Experiment duration	1 minute to 6 hours

